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AUTONOMOUS ORBIT CONTROL WITH ON-BOARD COLLISION RISK MANAGEMENT FOR LOW-EARTH ORBIT SATELLITES

Abstract

The use of Autonomous Orbit Control (AOC) for Low-Earth Orbit (LEO) satellites enables precise station-keeping around the reference orbit thanks to a high control reactivity. The mission scheduling is facilitated and ground operations are significantly reduced. AOC gains in value for very LEO satellites, for which atmospheric drag effects have to be countered by very frequent corrections.

Even if using AOC allows significant simplification of the station-keeping process, the assessment of debris collision risk becomes more complicated. Indeed, the drawback of on-board autonomy and reactivity is that station-keeping manoeuvres are not predictable, preventing the ground segment from managing the collision alerts process. In other words, collision risk assessment operated by the ground segment would strongly limit on-board autonomy.

This issue has led CNES, in partnership with TAS, to study the on-board possibility of collision risk management. The aim is to strengthen on-board autonomy, ensure station-keeping control reactivity and reduce ground operations even more. On-board collision risk management also improves the responsiveness of the avoidance strategy execution.

To this end, a method has been developed for both in-track and cross-track control taking into account the specificities related to collision risk calculation. In order to provide complete collision risk management, collision avoidance strategies are integrated into the algorithm. These methods, still in development phase and made compatible with low thrust corrections, will be presented in this paper.

The study initially focuses on achieving good station-keeping performance. To do this, simulation campaigns are carried out on several realistic LEO missions that differ in terms of orbits, propulsion capability and mission constraints. The next step is to demonstrate that the collision risk is correctly estimated on-board. In particular, using a realistic debris environment, it can be shown that the alert rate obtained is of a similar order of magnitude as its counterpart computed by an orbit control operated by the ground.

In conclusion, this work presents a new method for on-board station-keeping with collision risk management that opens up interesting prospects, particularly in a context of increasing use of large constellations for which on-board autonomy appears more essential than ever.